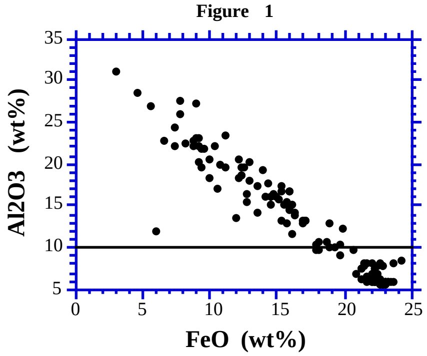
COMPOSITION AND TEXTURES OF IMPACT AND VOLCANIC GLASSES IN THE 79001/2 CORE. C. M. Weitz, M. J. Rutherford, and J. W. Head III, Department of Geological Sciences, Brown University, Box 1846, Providence, RI 02912.

Introduction: We have studied thin sections from the 79001/2 core taken on the rim of the 90 m diameter impact crater Van Serg. The core is a mixture of basalt and highland fragments, lithics, agglutinates, and impact and volcanic glasses. The core is significantly different from the 74001/2 core taken on the rim of the impact crater Shorty. While the 74001/2 core is composed of only orange glasses and their crystallized equivalents [1, 2] and therefore represents a stratigraphic section at depth, the 79001/2 core represents a mixture of components making up the regolith. Our interest in the 79001/2 core was to search for volcanic glasses and determine their relationship to those found at Shorty. Each of the 19 thin sections in the Van Serg core was studied and glasses were identified. Impact and volcanic glasses that had a unique texture were compositionally analyzed, as were 128 glasses from two thin sections in the core.

Approach: The thin sections were initially studied at the Johnson Space Center. Several distinct glasses were selected for probing using a Cameca SX-100 probe to produce digital elemental maps of Si, Al, Ti, Fe, and Mg. The thin sections were then transferred to Brown University where a Cameca Camebax was used to obtain quantitative measurements of glass compositions. For standards, we used a terrestrial basaltic glass composition. In addition, several beads from the Apollo 15 green glass (low-Ti) and the Apollo 17 74220 orange glass (high-Ti) were analyzed and re-normalized to values obtained by [3] for the Ap15 and Ap17 glasses. The re-normalized standards were then applied to the 79001/2 glass analyses. Spot size for each probe analysis was approximately 10 mm.

Figure 1



To distinguish between impact and volcanic glasses, we designated all glasses with <10 wt% Al_2O_3 and >10 wt% MgO compositions as volcanic because all the 25 lunar volcanic glasses identified by [3] fell within this category. Figure 1 shows a plot of FeO vs Al_2O_3 for the 128 glasses analyzed from two 79001/2 thin sections. The volcanic glasses below 10 wt% Al_2O_3 have the highest FeO content, supporting a more primitive and mafic composition.

Results for the Impact Glasses: The elemental maps were useful for identifying textures in the glasses and determining relative compositions. One particularly interesting and unique bead is 600 µm in diameter and is composed of an inner and outer zone, giving the appearance of an egg (figure 2). The outer zone is heterogeneous in composition and has a swirly orange/white texture in transmitted light. Its average composition is 10 wt% MgO, 11 wt% Al_2O_3, 44 wt% SiO_2, 10 wt% CaO, 6 wt% TiO_2, and 18 wt % FeO. Interspersed in the outer zone are small metal blebs with compositions of 89-94 wt% Fe, 6-10 wt% Ni, and 0.8 wt %Co. The inner zone ("the yolk") has a homogeneous composition of 36 wt% MgO, 37 wt% SiO_2, and 26 wt% FeO and is clear in transmitted light. The inner zone is an olivine crystal that was originally part of a basalt or an ultramafic rock. During an impact event, the olivine fragment became incorporated into an impact glass and partially melted at the contact zone. As the bead later cooled, smaller olivine crystals grew into the adjacent impact glass.

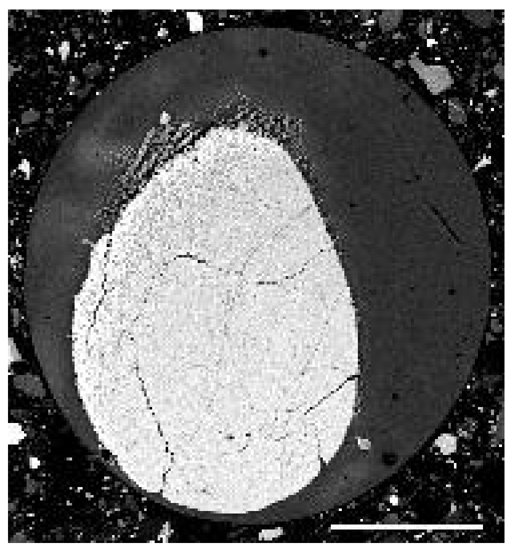


Fig. 2. Elemental map showing the distribution of MgO in an impact bead. Bar at bottom is 200 µm. Black dots in outer zone are Fe-rich metal blebs.

Many of the impact glasses have small metal blebs interspersed throughout them. Unlike the Fe-Ni metal blebs identified in the 74001/2 core which formed by oxidation of graphite in a magma at depth [4], the metal blebs in the impact glasses formed by reduction at the surface [5]. One 200 µm yellow glass bead has large metal blebs at the rim that progressively decrease in size moving inward. The correlation between bleb size and location from the rim suggests that the bead was molten and spinning in the air after formation, causing the metals to redistribute by size. Many other impact glasses have metal blebs only at their rims but all the blebs appear the same size. Other blebs inside impact glasses are located only between cracks in the glasses. Thus, the location and occurrence of metal blebs in the impact glasses appears to be a function of several factors. Finally, the larger impact glasses show partial crystallization and several clear glasses have brown devitrification textures, similar to those identified in the Apollo 17 orange glasses [6].

Results for the Volcanic Glasses: Of the 128 glasses analyzed, 51 had <10 wt% Al_2O_3 and >10 wt% MgO and were considered volcanic. The glasses are plotted as a function of MgO, TiO_2, and FeO in figures 3 and 4. The majority of volcanic glasses analyzed in this study fall within one of the five types identified by [7] or their fractionation trends for the Apollo 17 glasses. However, several do not and may

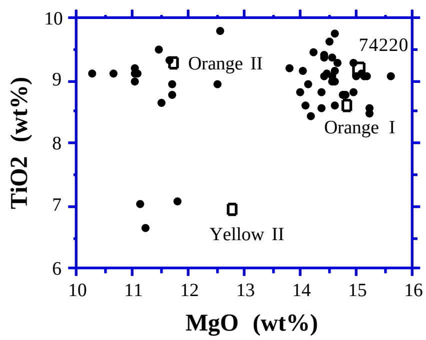


Fig. 3. MgO vs TiO_2 for the volcanic glasses analyzed. Squares represent the most primitive (i.e. highest MgO) for the different glass types (74220, Orange I, Orange II, and Yellow II) identified by [7]. (VLT glasses not shown).

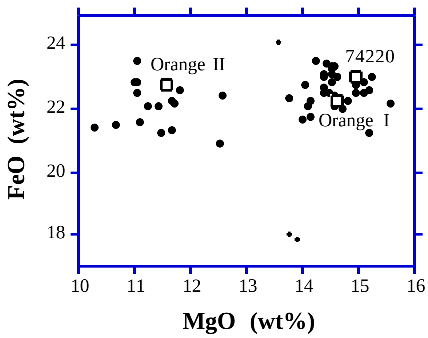


Fig. 4. MgO vs FeO for the volcanic glasses. The crosses represent the three very low-Ti (0.5-2.1 wt%) glasses identified in this study.

represent volcanic glasses transported by impacts from other locations or from smaller pyroclastic eruptions in the region.

Discussion: The dark mantle deposit of Taurus-Littrow is dominated by the 74220 glasses and their crystallized equivalents (black beads). Compositional analyses of the Shorty Crater core [8] indicate that the orange glasses are compositionally the same throughout the entire core and no fractionation trend can be identified within the 74220-type. However, the other glass types, including the Orange I, Orange II, and Yelow II all show limited fractionation trends [7]. This raises the important issue as to why the 74220 glasses experienced little, if any fractionation, while the other glasses did. The answer may lie in the style of eruption that emplaced the glasses.

Compared to the 74220 glasses, the other types most likely erupted from smaller eruptions in the area and did not contribute a substantial amount of material to the dark mantle deposit. The dark mantle deposit itself, which covers 1000's of km^2 in area and is probably several meters thick, is thought to have been erupted from a source vent located to the northwest which was later buried by the younger mare of Serenitatis [6]. To expel beads for 100's of kms to form a continuous deposit requires high mass effusion rates. For this larger, high mass effusion eruption, the ascending magma may not have had sufficient time to cool and fractionate. In contrast, the smaller eruptions that emplaced the other glasses may have stalled at depth until a foam layer composed of volatiles had built up sufficient pressure to cause an eruption. During the time that the magma remained stalled below the surface, it could have begun to cool and fractionate to produce the observed fractionation trends in the data. In addition, the higher MgO contents for the 74220-type support a more primary composition. A likely vent for the other types of glasses is the source head of the sinuous rille Rima Carmen located in the southern portion of the Taurus-Littrow deposit. Theoretical calculations [9] indicate that if only a few wt% of clasts ejected during the eruption are the submillimeter beads then they can be ejected as far away as the Van Serg location (~ 40 km distance).

References: [1] Heiken, G. H., D. S. McKay, and R. W. Brown, *Geochim. Cosmochim. Acta., 38*, 1703-1718, 1974; [2] Heiken, G. H., and D. S. McKay, *Proc. LPSC IX*, 1933-1943, 1978; [3] Delano, J. W., *Proc. LPSC XVI*, 201-213, 1986; [4] Weitz, C. M., M. J. Rutherford, and J. W. Head, *Geochim. Cosmochim. Acta., in press*, 1997; [5] Baedecker, P. A., C. L. Chou, and J. T. Wasson, *Proc. LPSC 3rd*, 1343-1359, 1972; [6] Weitz, C. M., J. W. Head, and D. S. McKay, *LPSC XXVII*, 1411-1412, 1996; [7] Delano, J. W., and D. H. Lindsley, *Proc. LPSC 14th*, B3-B16, 1983; [8] Blanchard, D. P., and J. R. Budahn, *Proc. LPSC IX*, 1969-1980, 1978; [9] Wilson, L., and J. W. Head, *J. Geophys. Res., 86*, 2971-3001, 1981.